Interactive coatings direct blood components to modulate coagulation in medical devices

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In medical devices, the contact of blood with the artificial surface inevitably causes the activation of coagulation. Immediately after the contact of blood with the surface, protein adsorption occurs. This leads to the reciprocal activation of factor XII and plasma prekallikrein generating large amounts of thrombin resulting in clot formation. Thus, the use of blood-contacting medical devices can lead to life-threatening complications such as thrombosis and stroke. In nature, the lining of healthy endothelium can sense and maintain a tightly regulated equilibrium called hemostasis that prevents hemorrhages and excessive coagulation. Our goal is to develop coatings inspired by the endothelium that turn the surface of medical devices hemocompatible to prolong their use without negative outcomes. Towards this aim, we develop nanoscale coatings that go beyond passivation by interacting with blood components and orchestrate a cascade of reactions to enhance their hemocompatibility and performance. The ultrathin nano-coatings include three hierarchical levels: a passive, a modulatory, and an interactive one. The passive level consists of antifouling polymer brushes or brush-like coatings that create a physical barrier to protein adsorption and cell adhesion, prohibiting surface-induced activation of coagulation.[1-3] The modulatory level is achieved by decorating the brushes with small biomolecules capable of binding to key elements of the coagulation cascade and inactivating them directly at the surface of the device. In contrast to anticoagulants, this approach allows a local inhibitory effect at the surface and does not interfere with hemostasis.[4,5] The interactive level can sense the presence of a thrombus formed somewhere else in the system and orchestrates its disintegration. We developed a fibrinolytic coating that is only active in the presence of a thrombus and directs its destruction using components present in the blood.[6] We envision that our ultrathin nano-coatings are a promising route toward the improvement of the hemocompatibility of medical devices.

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Figures

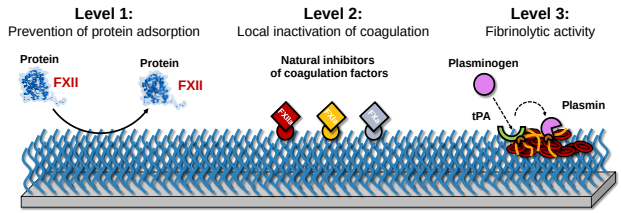

Figure 1. Scheme of the hemocompatible coatings that consist of three different levels. (1) The passive level prevents protein adsorption, (2) the modulatory level locally deactivates surface-induced coagulation, and (3) the interactive level digests an unwanted blood clot if it is necessary.